TREE FODDER IN UK LIVESTOCK SYSTEMS: OPPORTUNITIES AND BARRIERS

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Abstract

In northern European countries, there is little current understanding of the potential of tree fodder. This paper discusses the opportunities and barriers for tree fodder into UK ruminant livestock systems. Key opportunities include improving livestock nutrition and health (particularly as sources of minerals), and as a buffer against climate change impacts or shortages of forage. Key barriers are the mechanisation and management of tree fodder to reduce labour input, and regulatory restrictions that prevent tree and hedge cutting in summer months. Much of the information on tree fodder is anecdotal, and there is a real need for both scientific evidence and practical management advice on differences between tree species and seasonal variations in nutritional value. To take full advantage of this potential, better understanding of the nutritional and health benefits of tree fodder, and more efficient management techniques need to be developed.

Keywords: minerals; tannins; salicylic acid; silvopastoral systems

Introduction

Traditionally, tree fodder has been an important animal feed and remains significant in some farming systems (Eichhorn et al. 2006). However, in northern European countries, while the value of trees for shelter or shade is accepted, there is little current understanding of the potential of tree fodder. Nevertheless, tree fodder offers certain benefits such as buffering against the impact of climate change on forage resources, and meeting specific nutritional or health needs of the animals. The need for better estimates of the nutritional value of browse in relation to management of trees (e.g. impact of harvesting style on the quantity or quality of forage) was identified by European livestock stakeholders as a barrier to greater uptake of agroforestry systems (Hermansen et al. 2015). Can this traditional labour-intensive practice work in modern livestock systems? This paper discusses the potential integration of tree fodder into UK ruminant livestock systems. In addition to a brief overview of available evidence, results from tree fodder analyses carried out as part of the European research project AGFORWARD are presented and discussed.

What are the benefits of, and barriers to, wider use of tree fodder in the UK?

a) Livestock nutrition and health. Fodder from some tree species compare favourably with typical forages such as hay, grass silage and grazed grass (Ministry of Agriculture Fisheries and Food 1990). Of greater value, however, may be their potential as a source of minerals. For example, willow leaves are high in magnesium and zinc (Robinson et al. 2005) and alder is high in copper (Luske and Van Eekeren 2017). Secondary compounds such as condensed tannins can also be of benefit by increasing the flow of rumen-bypass protein and essential amino acids to the small intestine (Rogosic et al. 2006). The potential for self-medication in ruminants is not yet well explained in the scientific literature. Although salicin, in willow, is well known to have anti-inflammatory properties, it has not been widely evaluated in terms of its content within tree fodder or consequent effects on animal health (Boeckler et al. 2011). Comparatively little is known about the potential of temperate browse species, although the evidence base is slowly growing (Emile et al. 2016; Smith et al. 2012) and contributing to an on-line database of nutritional values (Luske et al. 2017).

b) Buffer against climate change impacts or shortages of forage. Trees provide alternative feed resources during periods of low forage availability. In northern temperate systems, this role may increase in importance as the effects of climate change impact on plant growth patterns. There is also potential for preserved tree fodder to fill the ‘hungry gap’ in early spring, before the new season grass is available, (e.g. by drying as ‘tree hay’ (Green 2016), or ensiled (Smith et al. 2014)).

c) Mechanisation and management. The simplest method of managing tree fodder is to allow livestock to have direct access, although this requires careful management that balances keeping tree height accessible to livestock with minimising damage to the tree. Manual cutting and transporting is laborious and time consuming, but there has been recent interest in mechanising the process; Dutch farmers have been investigating ensiling coppiced willow for feeding to dairy goats (see www.voederbomen.nl/oogst for a film of the process).

d) Regulatory restrictions. In England, under Cross Compliance regulations (which farmers must follow if they are claiming rural payments such as for the Basic Payment Scheme or Countryside Stewardship), hedges and trees must not be cut between 1^{st} March and 31^{st} August (although it is possible to coppice trees between 1^{st} March and 30^{th} April) (DEFRA 2017). This conflicts with tree fodder management options which would need to be done during the summer months. Direct browsing would still be possible though.

e) Knowledge gaps. Much of the information on tree fodder is anecdotal, and there is a real need for both scientific evidence and practical management advice on differences between tree species, seasonal variations in nutritional value and appropriate management systems.

Tree fodder analyses

Leaf samples were collected from SRC alder (*Alnus glutinosa*) and basket willow (*Salix viminalis*) in August 2015, and in June 2016 from an ash (*Fraxinus excelsior*), goat willow (*Salix caprea*) and elm (*Ulmus minor*) tree on Elm Farm, Hamstead Marshall, UK (51°23’14.19”N; 1°24’08.34”W). As part of a pilot study on the effect of air-drying tree fodder over winter and testing palatability, branches of the ash, goat willow and elm were bundled, tied and left to dry naturally in a covered barn from June to March (Figure 1a). Leaf samples were then taken before the bundles were fed to housed cattle (Figure 1b and see video at https://vimeo.com/217077820). Leaf samples were oven dried at 40°C until a stable weight was reached, and analysed for neutral detergent fibre (NDF), acid detergent fibre (ADF), lignin and digestible organic matter (DOM) by INRA in France, and for Ca, P, N, Mg, S, K, Fe, Mn, Cu, Zn and B by NRM (www.nrm.uk.com). Results contributed to the Tree Fodder on-line database managed by the Louis Bolk Institute (http://www.voederbomen.nl/nutritionalvalues/).

Figure 1: (a) Harvesting and bundling tree fodder from an ash tree, June 2016 (b) feeding air-dried tree fodder to cattle, March 2017.

Digestible organic matter (DOM) varied between species, with lowest levels recorded for *Salix viminalis* samples collected in August (Table 1). Similarly low levels (42.1%) were recorded in *Salix viminalis* samples from a UK silvoarable SRC system (Smith et al. 2012). However, DOM of the other species was higher (Table 1) and compares favorably with typical livestock forages. Lignin levels were higher in the *Salix viminalis* and *Alnus glutinosa* samples compared to the other three species; this may, however, be due to the samples being taken in August when leaves have matured and become lignified rather than reflecting any species differences.

Table 1: Chemical composition of tree leaves including neutral detergent fibre (NDF), acid detergent fibre (ADF), lignin and digestible organic matter (DOM). DM=dry matter.

Latin name	Date sampled	DM (%)	NDF (%DM)	ADF (%DM)	Lignin (%DM)	DOM (%)
Salix viminalis	Aug-15	33	37.29	22.12	11.33	55.29
Alnus glutinosa	Aug-15	38	37.61	24.76	13.51	76.19
Fraxinus excelsior	Jun-16	39	29.59	14.84	5.02	85.68
Salix caprea	Jun-16	35	32.15	20.57	8.77	73.51
Ulmus minor	Jun-16	37	43.06	12.15	3.31	77.72

The content of selected essential macro- and micro- minerals was tested for the five species of trees. Essential minerals are those which are known to have a metabolic function in animals or plants. All the tested elements increased in the air-dried leaves compared to fresh leaves although where levels were low in the fresh samples, this increase was minimal (Table 2). Levels of phosphorus (an essential element for bones) were highest in the dried goat willow (5.5 g/kg DM) but all trees compare favourably with grass at 2.8-3.5 g/kg DM, silage at 2.0-4.0 g/kg DM and hay at 1.5-3.5 g/kg DM (McDonald et al. 1995).

Table 2: Macro-elements of tree leaves.

Latin name	Date sampled	Ca (g/kg DM)	P (g/kg DM)	N (% w/w)	Mg (g/kg DM)	S (g/kg DM)	K (g/kg DM)
Salix viminalis	Aug-15	18.8	3	2.23	1.8	4.1	10.4
Alnus glutinosa	Aug-15	13.3	2.2	3.16	2.5	1.9	9.1
Fraxinus excelsior	Jun-16	12.8	3.1	1.78	2.2	1.8	14.1
F. excelsior (dried)	Jun-16	16	3.7	2.21	2.7	2.3	20
Salix caprea	Jun-16	10.2	4.2	2.66	1.9	2.1	13.9
S. caprea (dried)	Jun-16	14.5	5.5	2.16	2.7	2.6	19.0
Ulmus minor	Jun-16	11	2.3	2.23	1.9	1.3	14.7
U. minor (dried)	Jun-16	16.8	2.4	2.31	2.8	1.7	20.9

With regards micro-elements, willow was particularly high in zinc, with *Salix caprea* containing 144 mg/kg DM and *Salix viminalis* containing 245 mg/kg DM (Table 3) reflecting previous findings (e.g. Robinson et al. 2005). The level of zinc in willow is substantially higher than those found in grass at 5 mg/kg DM, in silage at 25-30 mg/kg DM and in hay at 17-21 mg/kg DM (McDonald et al. 1995). Zinc is present in all animal tissue, organs and bones, playing an important role in growth, cell repair, hormones, enzyme activation, the immune system, and skin integrity. Levels of iron were notably high in the dried samples and in elm, in particular, at 258 mg/kg DM (Table 3). *Salix viminalis* and *Alnus glutinosa* contained substantially higher levels of manganese than did other tree species (Table 3).

Table 3: Micro-elements of tree leaves.

Latin name	Date sampled	Fe (mg/kg DM)	Mn (mg/kg DM)	Cu (mg/kg DM)	Zn (mg/kg DM)	B (mg/kg DM)
Salix viminalis	Aug-15	73	284	5.5	245	36.7
Alnus glutinosa	Aug-15	92	129	11.2	53	28.9
Fraxinus excelsior	Jun-16	91	25	7.4	18	15.7
F. excelsior (dried)	Jun-16	116	32	9.6	23	17.5
Salix caprea	Jun-16	76	36	7.6	118	12.7
S. caprea (dried)	Jun-16	142	46	10.9	144	18.2
Ulmus minor	Jun-16	138	37	6.5	32	19.3
U. minor (dried)	Jun-16	258	38	9.3	40	26.0

Conclusion

Tree fodder has the potential to play a role in modern livestock systems in the UK; in particular the high levels of minerals in tree fodder suggest that trees can offer an alternative source of supplementation. The higher levels in dried samples, compared to fresh, suggest that there is scope to extend their value beyond the growing season. To take full advantage of this potential, better understanding of the nutritional and health benefits of tree fodder, and more efficient management techniques need to be developed.

Acknowledgements

Thanks to Philippe Barre and the team at INRA for analysing the tree fodder, and to Ted Green and Alun Davies for help with collecting the samples. The AGFORWARD project (Grant Agreement N° 613520; 2014-2017) was co-funded by the European Commission, Directorate General for Research & Innovation, within the 7th Framework Programme of RTD, Theme 2 - Biotechnologies, Agriculture & Food.

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